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**(54) Title:** OFFICE WASTEPAPER DEINKING PROCESS

**(57) Abstract**

This invention relates to a process for the deinking of office wastepaper stocks which comprises: a) converting the wastepaper to a pulp, b) contacting the pulp with an aqueous medium of alkaline pH containing between 0.05 and 2 percent by weight, calculated on a dry weight basis of the pulp, of a deinking agent comprising one or more alcohol ethoxycarboxylate surfactants of formula (I): R-O-(CH<sub>2</sub>-CH<sub>2</sub>O)<sub>n</sub>-X, wherein R is a straight-chain or branched-chain alkyl group having in the range of from 8 to 20 carbon atoms, n represents the average number of oxyethylene groups per molecule and is a number in the range of from 3 to 20, and X represents a carboxylate group, and c) treating the resulting pulp-containing medium by washing or flotation to remove suspended ink therefrom.

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## OFFICE WASTEPAPER DEINKING PROCESS

This invention relates to a process for the removal of ink from printed office wastepaper in the course of reclaiming the fiber content of the waste for reuse in the manufacture of new paper. More particularly, the 5 invention relates to a process for the deinking of office wastepaper containing xerographically printed paper or paper printed using a laser printer and/or ledger printed paper.

Wastepaper has long served as a source of the raw 10 fiber materials used in papermaking. Traditionally, fiber from wastepaper was utilized only in the production of low grade paper and paperboard products. Today, however, greater utilization of reclaimed fiber has provided incentive for taking steps to upgrade the 15 reclaimed product. These steps include treatment to effectively remove ink from waste fibers in order to permit their use in the manufacture of newsprint and high quality papers. Increasing amounts of office waste paper are becoming available. Because of the high quality 20 cellulose fiber in office waste paper, efficient ink removal is particularly desirable since excellent quality, high value products can be prepared from this deinked pulp.

In the course of the conventional paper reclamation 25 process of interest, deinking procedures include steps for converting the wastepaper to pulp and contacting the pulp with an alkaline aqueous deinking medium containing a chemical deinking agent. The physical pulping and the alkalinity of the aqueous medium cause the partial 30 detachment of ink from the cellulose paper fibers and the deinking agent completes this removal and produces an

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5 aqueous suspension and/or dispersion of the ink particles thus detached from the paper cellulose fibers. The chemical deinking agent plays an important role in determining the size and geometry of the dispersed ink particles. The resulting mixture is subsequently treated to separate the suspended ink from the pulp.

10 A variety of materials, particularly surfactants and mixtures of surfactants are known to be useful as deinking agents in such a process, at least when the process is applied to the deinking of such common wastepaper stocks as newsprint, book, magazine and ledger. It is recognized, however, that conventional processes have not been particularly successful in 15 specific application to xerographically printed wastepapers and laser printed wastepapers. The difficulty encountered in the deinking of these wastepapers has been attributed to the character of electrostatic ink, specifically the vehicle, which is fundamentally different from that used in other printing 20 processes. For example, in distinction to the common oil or aqueous vehicles of other inks, the electrostatic ink vehicle is typically a polymeric material (e.g., copolymers of styrene and acrylate monomers, copolymers of styrene and butadiene, and polyester resins) which 25 during the printing process is fixed to the paper by application of heat.

30 The ever-increasing utilization of xerographic and laser printed paper has made reclamation of office wastepaper containing xerographically and laser printed paper economically attractive. Accordingly, the object of the present invention is a deinking process which is effective in the treatment of office wastepaper stock. As used herein, "office wastepaper" refers to 35 xerographically printed stocks which may contain other materials such as laser printed stocks and ledger stocks,

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including mixtures of xerographically printed stocks or laser printed stock and ledger printed stocks.

The present invention centers on the use in a deinking process of a chemical deinking agent which 5 comprises an alcohol ethoxycarboxylate surfactant component, and optionally, a component comprising a detergent-range alcohol. It is known in the art that the removal of ink from wastepaper can be accomplished by a process in which the paper is reduced to pulp and the 10 pulp is contacted with an aqueous medium containing a surfactant as a deinking agent. For example, it is known from U.S. Patent No. 4,561,933, that xerographically printed wastepaper can be deinked using a mixture of one or more C<sub>5</sub> to C<sub>20</sub> alkanols and nonionic surfactant. It 15 is also known in the paper deinking art (for example, U.S. Patent No. 4,162,186) to employ chemical agents which are ethylene oxide adducts ("ethoxylates") of detergent-range alcohols or alkyl-substituted phenols containing an average of about 7 to about 15 oxyethylene 20 units per molecule of alcohol. It is further known from U.S. Patent No. 4,518,459 to use surfactants for deinking which are hydroxy-terminated or benzyl ether-terminated 25 ethylene oxide-propylene oxide adducts (ethoxy-propoxylates) of high molecular weight or long chain alcohols.

It has now been found that a combination of one or more alcohol ethoxycarboxylates is very usefully applied as a deinking agent in process for the deinking of office wastepaper. Processes applying this deinking agent are 30 found to offer a high level of performance from the standpoint of the overall brightness and low level of residual visible ink particles in papers prepared from the deinked pulp. In addition, the invention provides for low foaming and high biodegradability without adverse

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influence upon deinking performance and reclaimed paper product brightness.

The invention therefore relates to a process for the deinking of office wastepaper stocks which comprises:

- 5 a) converting the wastepaper to a pulp,
- b) contacting the pulp with an aqueous medium of alkaline pH containing between 0.05 and 2.0 percent by weight, calculated on a dry weight basis of the pulp, of a deinking agent comprising one or more

10 alcohol ethoxycarboxylate surfactants of the formula



wherein R is a straight-chain or branched-chain alkyl group having in the range of from 8 to 20 carbon atoms, n represents the average number of oxyethylene groups per molecule and is a number in the range of from 3 to 20, and X represents a carboxylate group, and

- 15 c) treating the resulting pulp-containing medium by washing or flotation to remove suspended ink therefrom.

20 The present invention is generally applicable to the deinking of the office wastepaper stocks, and also to practices and procedures conventionally employed for their processing. Generally, any such process comprises three principal steps: the first, a step to reduce the wastepaper feed to pulp, the second, a contact between the pulp and an alkaline aqueous medium containing the deinking agent to produce a suspension or dispersion of the ink, and, the third, a treatment of the resulting pulp containing medium to remove suspended or dispersed ink particles therefrom. The first two steps of the process, however, may be combined.

25 The present invention centers upon the composition and performance of the deinking agent. For purposes of

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the invention, the deinking agent is one or more alcohol ethoxycarboxylate surfactants, represented by the formula



wherein R is a straight-chain or branched-chain alkyl group having in the range of from 8 to about 20, preferably from 12 to 18 carbon atoms, n represents the average number of oxyethylene groups per molecule and is a number in the range of from 3 to 20, preferably in the range of from 3 to 13, and more preferably in the range of from 3 to 7, and X represents a carboxylate group.

The alkyl group R can have a carbon chain which is straight or branched. Preferably, about 80 percent of the R groups in the alcohol ethoxycarboxylates utilized in the instant invention are straight-chain. It is understood that R can be substituted with any substituent which is inert such as, for example, halogen groups. The carboxylate group X is preferably either a  $-OCOOM$  formate group or a  $-OCH_2COOM$  acetate group. The surfactants are utilized in the salt form, with M representing a mono-valent inorganic cation such as, for example, an alkali metal or ammonium cation.

Alcohol ethoxycarboxylate surfactants of formula (I) are known in the art to be prepared by a process which comprises an ethoxylation reaction between an alcohol reactant comprising one or more alcohols of the formula ROH and an ethylene oxide reactant, in relative quantities of n moles of ethylene oxide for each mole of alcohol, followed by reaction of the resulting ethoxylate mixture with, for example a salt of a corresponding chlorocarboxylic acid. Suitably, the alcohol reactant is a primary or secondary, straight-chain or branched alcohol having from 8 to 20, preferably from 9 to 15, and more preferably from 12 to 15 carbon atoms. The most common ethoxycarboxylates in this class and the ones which are particularly useful in this invention are the

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primary alcohol ethoxycarboxylates, i.e., compounds of formula I in which R is an alkyl group and the  $-O-(CH_2-CH_2O)_n-X$  ether substituent is bound to a primary carbon of the alkyl group.

5       Alcohols which are suitable for ethoxylation to form the alcohol ethoxycarboxylate component of the deinking agent of the instant invention include coconut fatty alcohols, tallow fatty alcohols, and the commercially available synthetic long-chain fatty alcohol blends, 10 e.g., the C<sub>12</sub> to C<sub>15</sub> alcohol blends available as NEODOL 25 Alcohol (a registered trademark of product manufactured and sold by Shell Chemical Company), the C<sub>14</sub> to C<sub>15</sub> alcohol blends available as NEODOL 45 Alcohol, the C<sub>12</sub> to C<sub>14</sub> alcohol blends available as Tergitol 24L (a 15 registered trademark of product manufactured and sold by Union Carbide Corporation), and the C<sub>12</sub> to C<sub>13</sub> alcohol blends available, for example, as NEODOL 23 Alcohol (Shell).

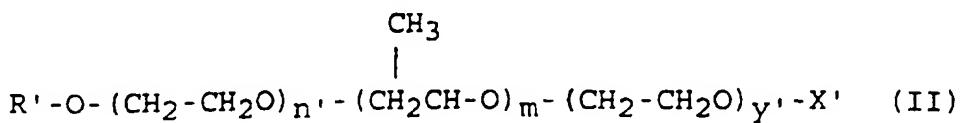
20       Suitable alcohol ethoxycarboxylates can be prepared by adding to the alcohol or mixture of alcohols to be ethoxycarboxylated a calculated amount, e.g., from 0.1 to 0.6, preferably from 0.1 to 0.4 percent by weight, based on total alcohol, of an ethoxylation catalyst which may be either acidic or basic. An alkali metal or 25 alkaline earth metal hydroxide such as sodium hydroxide or potassium hydroxide, is a very suitable ethoxylation catalyst. The resulting mixture is dried, as by vapour phase removal of any water present, and an amount of ethylene oxide calculated to provide the desired number 30 of moles of ethylene oxide per mole of alcohol is then introduced and the alcohol ethoxylate is allowed to react until the ethylene oxide is consumed, the course of the reaction being followed by the decrease in reactor pressure.

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The resulting alcohol ethoxylate product is a mixture of compounds of the formula  $R-O(CH_2CH_2)_y-OH$ , having a range of values for  $y$  which are conveniently represented by an average value  $n$ . The ethoxylate product is then 5 converted to the desired alcohol ethoxycarboxylate by known methods, for instance by reaction with a corresponding salt of chloroformic acid or chloroacetic acid in the presence of an alkali or alkaline earth metal hydroxide. Conversion of alcohol ethoxylates to the 10 desired alcohol ethoxycarboxylates is also known to be accomplished by oxidation of the ethoxylates such as, for example, by reaction of the ethoxylate with a corresponding salt of a nitric acid in the presence of a stable free radical nitroxide, such as 4-hydroxy- 15 2,2,6,6-tetramethylpiperidin-1-oxyl and the like, and an oxidant.

Alcohol ethoxycarboxylates prepared by a variety of processes and suitable for use in the present invention are available commercially, e.g., the  $C_{12}$  to  $C_{13}$  alcohol blends available as NEODOX 23-4 Alcohol Ethoxycarboxylate (a trademark of product manufactured and sold by Shell Chemical Company), and the  $C_{12}$  to  $C_{15}$  alcohol blends available, for example, as NEODOX 25-11. 20

Also suitable as a carboxylate deinking agent in the 25 deinking process of the present invention is a carboxylate containing both oxyethylene and oxypropylene units such as, for example, an alcohol alkoxycarboxylate having the formula



wherein  $R'$  is a straight-chain or branched-chain alkyl 30 group having in the range of from 8 to 20 carbon atoms,  $n'$  represents the average number of oxyethylene groups

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per molecule and is a number in the range of from 0 to 20, m represents the average number of oxypropylene groups per molecule and is a number in the range of from 1 to 12, y' represents the average number of oxyethylene groups per molecule and is a number in the range of from 1 to 20, and X' represents a carboxylate group. When n' is 0, these propoxyethoxycarboxylates are typically derived by propoxylation of primary or secondary, straight-chain or branched alcohols followed by ethoxylation of the propoxylate formed. The propoxyethoxylate product is then converted to the desired alcohol propoxyethoxycarboxylate by known methods, for instance by reaction with a corresponding salt of chloroformic acid or chloroacetic acid in the presence of an alkali or alkaline earth metal hydroxide. Conversion of alcohol propoxyethoxylates to the desired alcohol propoxyethoxycarboxylates is also known to be accomplished by oxidation of the propoxyethoxylates such as, for example, by reaction of the propoxyethoxylate with a corresponding salt of a nitric acid in the presence of a stable free radical nitroxide, such as 4-hydroxy-2,2,6,6-tetramethyl-piperidin-1-oxyl and the like, and an oxidant. When n' is 1 or greater, these ethoxypropoxyethoxycarboxylates are typically derived by ethoxylation of primary or secondary, straight-chain or branched alcohols followed by propoxylation of the ethoxylate formed followed by ethoxylation of the propoxyethoxylate formed. The ethoxypropoxyethoxylate product is then converted to the desired alcohol ethoxypropoxyethoxycarboxylate by known methods, for instance by reaction with a corresponding salt of chloroformic acid or chloroacetic acid in the presence of an alkali or alkaline earth metal hydroxide. Conversion of alcohol ethoxypropoxyethoxylates to the desired alcohol ethoxypropoxyethoxycarboxylates is also known to

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be accomplished by oxidation of the ethoxypropoxyethoxylates such as, for example, by reaction of the ethoxypropoxyethoxylate with a corresponding salt of a nitric acid in the presence of a stable free radical nitroxide, such as 4-hydroxy-2,2,6,6,tetramethyl-piperidin-1-oxyl and the like, and an oxidant.

If desired, other deinking agents may be present in addition to the alcohol ethoxycarboxylate deinking agent, such as, for example, alcohol ethoxylates, particularly detergent-range alcohol ethoxylates having from 3 to 20 oxyethylene oxide units per molecule of alcohol; alcohols, particularly detergent-range alcohols having 8 to 20 carbon atoms; olefins, particularly detergent-range olefins having from 8 to 22 carbon atoms; saturated hydrocarbons having from 8 to 20 carbon atoms, e.g. decane, dodecane, etc.; propoxyethoxylates; glycols; fatty acids; fatty acid propoxyethoxylates and the like. Particularly good results have been obtained with glycols, such as, for example, hexylene glycol.

The invention applies the deinking agent comprising one or more alcohol ethoxycarboxylate surfactants to wastepaper which is necessarily in the form of a pulp, that is, to wastepaper which has first been substantially reduced to the individual fibers. Pulping is suitably conducted using any of the various conventional processes and equipment designed for this purpose. Most conveniently, the wastepaper process feedstock is treated in a device known as a "hydropulper", which produces a slurry of the fibers in water having a pH of about 9 to about 12.

After the pulping step, the resulting fibers are contacted in an aqueous medium with the deinking agent. This contacting step may suitably be carried out in the pulping equipment, for example, by simply adding deinking agent and caustic to the aqueous slurry of the hydra-

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pulper. This may be done either before or after addition of the wastepaper to the hydropulper. Alternatively, the contact may be carried out using separate processing equipment such as for example, kneaders and dispersers, which provides for agitation of the aqueous pulp slurry. For the contact step, the solids content of the pulp is present in a quantity typically between 0.5 and 30.0 percent by weight, calculated as the dry weight of the wastepaper feed relative to total weight of the slurry formed. In a preferred embodiment, the slurry contains between 5 and 20 percent by weight paper fiber. The amount of deinking agent present in the slurry is suitably between 0.05 and 2.0 percent by weight, calculated basis dry fiber weight. In a preferred embodiment, the quantity of deinking agent utilized is between 0.1 and 1.0 percent by weight, with between 0.2 and 0.5 percent by weight being particularly preferred.

During contact between the pulp fiber and the deinking agent, it is preferable that the aqueous contact medium be maintained at alkaline pH. A pH value greater than 7 is preferred, a pH between 7 and 13 is more preferred, and a pH between 8 and 10 is generally most preferred. The alkalinity is generally maintained by the addition of base such as, for example, caustic or sodium silicate, to the aqueous contact medium. Typically, the amount of base added to the contact medium is in the range of from 1 to 4 percent by weight calculated basis the dry weight of the pulp fiber.

In addition to water, pulp, base and deinking agent, the contact slurry may further contain other substances conventionally employed in deinking processes such as, for example, brighteners, solvents, antifoam agents, water softeners and the like. These substances, if present, along with additional deinking agents, if present, may be added to the pulper when the alcohol

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ethoxycarboxylate deinking agent is added, or they may be added to separate process equipment. However, neither the use of these substances nor the use of additional deinking agents is necessary.

5 Processing of the pulp slurry during contact with the deinking agent is preferably carried out at elevated temperatures, particularly temperatures in the range of from 30 °C to 95 °C. The invention has been found to be particularly effective at a temperature in the range of  
10 from 35 °C to 70 °C, while a temperature in the range of from 40 °C to 60 °C is considered especially preferred.

15 The contact time for the wastepaper pulp and the aqueous deinking medium is not critical for purposes of this invention. However, a contact time of greater than 10 minutes is preferred from the standpoint of deinking performance. For purposes of process efficiency, it is preferred that the contact time be in the range of from 15 minutes to one hour, and more preferred that the contact time be in the range of from 20 minutes to  
20 50 minutes.

25 Following the contact step between the pulp and the aqueous medium containing the deinking agent comprising one or more alcohol ethoxycarboxylate surfactants, the mixture is treated for separation between the pulp fibers and the ink particles which are both dispersed, or suspended, in the medium. Separation of one or the other from the medium is suitably carried out by techniques commonly applied in conventional deinking practices, including those treatments known in the art as washing and flotation. In washing, the ink particles are rinsed from the pulp by contact with a flow of water, usually a countercurrent flow relative to the pulp. Among the devices commercially used for washing and suitable for use in the practice of the present invention are the  
30 sidehill screen, the gravity decker or drum washer, the  
35

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inclined screw extractor, the screw press, and the twin wire press. Centrifugal cleaners of various designs may also be used to separate the ink from the pulp.

5 Flotation methods of ink isolation generally involve bubbling a stream of air or another gas through the pulp. The air bubbles rise to the surface and carry the ink particles with them thereby generating foam which can be separated. It will be understood that in addition to pulping, contact and ink removal steps described herein, 10 the invention may be practiced using other process steps as are employed in wastepaper reclamation operations in general and office wastepaper in particular.

The invention will be described below by the following examples.

15 Example 1

This example illustrates the deinking of xero-graphically printed paper carried out using a deinking agent comprising 0.25% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 20 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule and a terminal carboxylate group).

25 To test the performance of the invention, the following procedures were carried out for the deinking of xerographically printed wastepaper.

Sample Preparation. Xerographically printed paper was aged at least three days and then shredded by hand and mixed well. Multiple copies of the same printed page were used.

30 Hydropulping and Deinking. Deionized water was heated to 40-45 °C. Sodium hydroxide pentahydrate was added to adjust the pH to about 9. To this was added 0.5 grams of the deinking agent (0.25% weight calculated on the weight of the pulp). This was added as a 1% 35 solution or dispersion in deionized water. A slurry of

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about 5% consistency was prepared by adding 20 grams of shredded xerographically printed paper. This slurry was mixed for 30 minutes in a Hamilton-Beach mixer on the high speed stir setting.

5 This slurry was separated into two equal portions. One portion of the slurry was made into sheets using Buchner funnel filtration. The other portion was subjected to flotation.

10 Flotation. Deionized water was heated to 40°-45 °C and 2 litres placed in a Denver Flotation Machine. This unit consists of a stir motor, an impeller shaft and stirrer blade and a container for the pulp slurry. As the slurry is stirred, air is drawn down the hollow stirrer shaft and exits at the stirrer blades through 15 small holes. The air bubbles created in the fashion rise through the pulp slurry taking ink particles with them. The froth at the top of the container is removed to separate the ink particles from the pulp slurry.

20 The pulp slurry was added to the container and diluted to a total volume of 2.5 litres using additional 40°-45 °C tap water. Pulp slurry consistency was 0.8% by weight. This mixture was stirred for 10 minutes at 900 revolutions per minute while slurry foam was skimmed off and collected.

25 The slurry was decanted from the flotation cell without pulp loss.

30 Paper Making. Deinking process performance was measured by making paper from the deinked pulp and analyzing the paper for brightness and visible ink particles. The standard of comparison for determining the percent of visible ink particle removed was the paper sheets made immediately after pulping. The pulp was divided into four portions so that at least three, and preferably four, handsheets each weighing 2-4 grams could be made. Each portion of pulp was dispensed in 40°-45 °C

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tap water and poured into a Buchner funnel fitted with Whatman Number 40 filter paper and placed in a vacuum flask connected to a house vacuum line.

5 In the Buchner funnel, pulp was deposited forming a wet sheet, through which water drained rapidly. The sheet thus formed was covered with two pieces of thick dry filter paper (two above and two below) and the several layers then squeezed by rolling with a 13.6 kg rolling pin. The layers were next removed from the 10 apparatus and the prepared sheet separated from the filter papers. Finally, the prepared sheet was placed between four thick filter papers (two above and two below), pressed with a force of 445 kPa, and dried 15 between fresh thick filter papers at room temperature in the dark for 24 hours.

20 The papers ("Buchner funnel pads") thus prepared were analyzed for brightness. Brightness measurements were made on the basis of percent light reflection from the sheet, using a standardized Technidyne Technibrite ERIC 950 meter. Eight measurements were made for each sheet, one at the center of each of four quadrants on both sides, and the eight values averaged for the sheet. Normally, the eight separate measurements varied over a 25 range of no more than about 1%. Reported brightness readings were the average of the brightness results for at least three similarly processed sheets.

30 The hand sheets were inspected for visible ink particles using an image analysis method. Images of the entire sheet were directly input into an Applied Vision Systems ASA 2000 Image Analyzer. The visible ink particle count (in parts per million) was determined for particles larger in area than 0.02 square millimeters.

The results of these tests are presented in Table I.

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Example 2

The procedures of Example 1 were repeated with the exception that the deinking agent used was 0.1% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule and a terminal carboxylate group).

The results are presented in Table I.

Example 3

The procedures of Example 1 were repeated with the exception that the deinking agent used was a 0.05% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule and a terminal carboxylate group).

The results are presented in Table I.

Example 4

The procedures of Example 1 were repeated with the exception that the deinking agent used was a 3:1 ratio of 0.25% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule and a terminal carboxylate group) to NEODOL 1 (a C<sub>11</sub> predominantly linear and primary alcohol).

The results are presented in Table I.

Example 5

The procedures of Example 1 were repeated with the exception that the deinking agent used was a 1:3 ratio of 0.25% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule

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and a terminal carboxylate group) to NEODOL 45-7 (a mixture of C<sub>14</sub> to C<sub>15</sub> predominantly linear and primary alcohols, i.e., about 52% wt. C<sub>14</sub> and 48% wt. C<sub>15</sub>, containing an average of 7 oxyethylene units per molecule).

5

The results are presented in Table I.

Example 5

The procedures of Example 1 were repeated with the exception that the deinking agent used was a 1:1.5:1.5 ratio of 0.25% by weight of NEODOX 23-4 Alcohol Ethoxycarboxylate (a mixture of C<sub>12</sub> to C<sub>13</sub> predominantly linear and primary alcohols, i.e., about 51% wt. C<sub>12</sub> and 49% wt. C<sub>13</sub>, containing an average of 4 oxyethylene units per molecule and a terminal carboxylate group) to NEODOL 45 (a mixture of C<sub>14</sub> to C<sub>15</sub> predominantly linear and primary alcohols, i.e., about 52% wt. C<sub>14</sub> and 48% wt. C<sub>15</sub>) to NEODOL 45-7 (a mixture of C<sub>14</sub> to C<sub>15</sub> predominantly linear and primary alcohols, i.e., about 52% wt. C<sub>14</sub> and 48% wt. C<sub>15</sub>, containing an average of 7 oxyethylene units per molecule).

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The results are presented in Table I.

Example 7

The procedures of Example 1 were repeated with the exception that the temperature utilized was 32 °C.

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The results are presented in Table I.

Comparative Example A

The procedures of Example 1 were repeated with the exception that no deinking agent was used.

The results are presented in Table I.

30

Comparative Example B

The procedures of Example 1 were repeated with the exception that the deinking agent used was NEODOL 1 (a C<sub>11</sub> predominantly linear and primary alcohol).

The results are presented in Table I.

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TABLE I

Ex.	Deinking Surfactant	% Visible Ink Removal		Residual Ink Surface Area (ppm)	ISO Brightness (%)	
		Flotation	Wash		Flotation	Wash
1	0.25% wt. NEODOX 23-4	98.8	97.2	31	57	91
2	0.1% wt. NEODOX 23-4	99.4	99.2	24	30	91
3	0.05% wt. NEODOX 23-4	86.6	87.3	486	312	90
4	0.25% 3:1 NEODOX 23-4: NEODOL 1	98.4	99.7	43	7	94
5	0.25% 1:3 NEODOX 23-4: NEODOL 45-7	99.6	100.0*	4	0	92
6	0.25% 1:1.5:1.5 NEODOX 23-4:NEODOL 45-7					92
7	0.25% NEODOX 23-4	98.4	97.9	21	27	90
Comp.		14.6	-	1,050	1,434	86
Ex. A	None					87
Comp.						
Ex. B	0.25% wt. NEODOL 1	97.6	95.8	79	131	90

\*No ink detected.

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Discussion of the Results

As can be seen in Table I, an alcohol ethoxy-carboxylate provided very high ink removal after flotation deinking at surfactant treatment levels as low as 0.1% relative to dry wastepaper weight (Examples 1-2). Additional ink was not always removed in a subsequent wash deinking step. When the alcohol ethoxycarboxylate treatment level was decreased to 0.05% (Example 3) ink removal was less efficient than at higher treatment levels (Examples 1-2).

The treatment level of alcohol ethoxycarboxylate in the Example 4 surfactant blend was 0.0625% indicating that the alcohol ethoxycarboxylate treatment level can be reduced to less than 0.05% if the alcohol ethoxy-carboxylate is formulated with carefully chosen ingredients such as NEODOL 1, a C<sub>11</sub> linear alcohol (Example 4), and a C<sub>14-15</sub> linear alcohol reacted with 7 moles of ethylene oxide per mole of alcohol (Example 5).

Example 6 illustrates that effective deinking surfactants containing low levels of alcohol ethoxycarboxylates may also be made by blending the alcohol ethoxycarboxylate with both a linear alcohol and an alcohol ethoxylate.

Comparison of Examples 1 and 7 indicates there is no significant loss in deinking effectiveness when the process temperature is decreased from 71 °C (Example 1) to 32 °C (Example 7).

CLAIMS

1. A process for the deinking of office wastepaper stocks which comprises:
  - a) converting the wastepaper to a pulp,
  - b) contacting the pulp with an aqueous medium of alkaline pH containing between 0.05 and 2 percent by weight, calculated on a dry weight basis of the pulp, of a deinking agent comprising one or more alcohol ethoxycarboxylate surfactants of the formula
$$R-O-(CH_2-CH_2O)_n-X \quad (I)$$
wherein R is a straight-chain or branched-chain alkyl group having in the range of from 8 to 20 carbon atoms, n represents the average number of oxyethylene groups per molecule and is a number in the range of from 3 to 20, and X represents a carboxylate group, and
  - c) treating the resulting pulp-containing medium by washing or flotation to remove suspended ink therefrom.
2. The process of claim 1 wherein X is selected from the group consisting of a formate group, an acetate group and mixtures thereof.
3. The process of claim 1 wherein R is an alkyl group having from 12 to 18 carbon atoms and n is in the range of from 3 to 13 oxyethylene units per molecule of alcohol.
4. The process of claim 1 wherein said deinking agent additionally contains a component selected from the group consisting of alcohols, propoxyethoxylates, glycols, fatty acids, fatty acid propoxyethoxylates and mixtures thereof.

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5. The process of claim 4 wherein said deinking agent has a ratio of first component to second component in the range of from 10:1 to 1:1.

6. The process of claim 1 wherein the aqueous medium contains between 0.5 and 30 percent by weight of pulp and step b) of the process is carried out at a temperature in the range of from 30 °C to 95 °C.

10. The process of claim 6 wherein the aqueous medium contains between 5 and 20 percent by weight of pulp and step b) of the process is carried out at a temperature in the range of from 40 °C to 70 °C.

8. The process of claim 1 wherein the aqueous medium of alkaline pH has a pH in the range of from 8 to 10.

15. The process of claim 1 wherein in step b) said deinking agent is added in a quantity between 0.1 to 1.0 percent by weight.

10. The process of claim 9 wherein in step b) said deinking agent is added in a quantity between 0.2 to 0.5 percent by weight.